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# Influence of climate change on the rates of gully growth in the vyatka-kama watershed

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## Abstract

Mean annual rates of gully head retreat were assessed based on the results of monitoring (period 1978- 2014) of more than 120 gully heads located within 28 sites over the Vyatka-Kama intcrfiuve area. The main attention was given to evaluation of the ratio of snowmelt- and rainstorm-induced erosion in the total figure of gully head retreat in the entire period of observation. The other focus was the evaluation of the relative contribution ofdifferent soil and climatic factors to the gully growth rates in the period 1998-2014. It was found that the mean annual gully head retreat rates had decreased from 1.3 m/year in 1978-1997 to 0.3 m/ycar in 1998- 2014. Observations at a number of locations nearby the Izhevsk city allowed to estimate that the total amount of gully head retreat associated with the snowmelt season had decreased from 80% in 1978-1998 to 53% in the following period. This decline was driven by the considerable decrease of snowmelt water runoff, which in turn was caused by warming of winters and in particular by the decrease of recurrence of winters when the average depth offrozen soil exceeded 50 cm. In the Udmurt Republic, the number of rainstorms capable of production of surfacc water runoff had increased in 1983-2014 by 20% compared to the period 1962-1982. Therefore, one can suggest that before 1982, the contribution of rainstorm runoff to the mean annual gully head retreat rate was even less than 20%. Rainstorm frequency was found to have not changed significantly during 1983-2014. The most important contribution to gully growth during the warm part of the year comes from rainstorms with the amount of precipitation above 40 mm per one event.

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## Keywords

Climate change, Gully head retreat rate, Rainstorm water runoff, Snowmelt water runoff, Udmurt republic

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